Surface Water Quality Modeling CEE 577
Course Outline- Spring 2020

Instructor: C.D. Guzman, Assistant Professor
21 Marston Hall, Civil and Environmental Engineering Department
545-1510, cdguzman@umass.edu
Class Hours: Lecture: MWF 9:05-9:55; Engineering Laboratory Rm 305,
Office Hours: 10:10 am-11:00 pm, Wednesday & Thursday

Computer: We will access computer models in MATLAB, Microsoft Excel, R, etc.

Objectives (Catalog Description): Evaluation and control of water quality in streams, lakes, and estuaries. Mathematical analyses of patterns of water movement and their relation to water quality. Total Maximum Daily Load (TMDL) allocation design. *Prerequisite*: CEE 370. [MATH 331, CHEM 112, CEE 357]

Goals (similar to ABET Outcomes) for CEE 577

1. To provide a fundamental understanding of the means by which water quality models are formulated so that the students are able to adapt existing models to new situations.
2. To provide the students with some direct exposure to models currently used in environmental engineering practice for predicting water quality in rivers and lakes. This will equip them with the knowledge to apply such models to solve simple wasteload allocation problems.
3. To instruct as to how water quality data can be analyzed and interpreted
4. To show how water quality models may be calibrated, verified, and applied to environmental engineering problems, such as total maximum daily loads or fate and transport modeling of toxic organic chemicals.
5. To further develop the students' skills at working in teams, and presenting results in the form of written engineering reports and oral presentations to clients or to the public.
6. To acquaint the student with current issues in surface water quality; and to make them aware of the technical, political, ethical and sociological components of these issues.

Coursework (Outcome Measures and Assessment): The Instructor will assess the student performance by grading the following coursework:

• 2 Exams	@ 20% Each	(40% total)
• 6 Problem Sets	@ 4% Each	(24% total)
• Reflections	@ 5% Total	(5% total)
• Workshop	@ 2% Each	(6% total)
• Design\Modeling Paper	@ 10%	
• Design\Modeling Presentation	@ 15%	
		(100%)

You must accumulate at least 60% to pass the course.

Exams: Exams will be proctored, timed, tests of your individual knowledge. Calculators should be brought to exams, but no other electronic devices are permitted (e.g. no cell phones, iPads, tablets, etc., no electronic access to pdfs). One prepared sheet (of Equations/Definitions) will be allowed.

Homework Problem Sets: The problem set questions will be listed at the start of each lesson. Your solutions must be turned in as hardcopy form on engineering grid paper. Multiple pages must be

stapled and have your last name at the top-right. *These will be collected from you in class only, and on the due date. No late homework, and no handing in of assignments by someone else. Your corrected problem sets and exams will be available in class following three class sessions, to be picked up by you, and only you.*

Reflections and Workshops: 30 reflections (submitted to website, posted to blogsite (cee5772020.tumblr.com), code via course number) will be incorporated into the daily lesson plans to prompt individual participation. Students will host a short in-class workshop (up to 3 times) on a journal article that describes, develops, or critiques a surface water quality model, concept, or theory.

Students will evaluate the course design and materials as well as the instructor at the end of the semester to provide feedback to the department on the perceived quality of the learning resources and the effectiveness of the instructor's content delivery.

Announcement about Disability Services (DS): The University of Massachusetts Amherst is committed to making reasonable, effective, and appropriate accommodations to meet the needs of students with disabilities and help create a barrier-free campus. If you have a documented disability on file with Disability Services (www.umass.edu/disability), you may be eligible for reasonable accommodations in this course. If your disability requires an accommodation, please notify your instructors as early as possible in the course so that we may make arrangements in a timely manner.

Cell Phones: Please ensure that you turn off mobile devices or set them to airplane mode before lectures.

Required Text: Chapra, S.C. Surface Water Quality Modeling, Paperback: Waveland Press, 2008, or Hardbound: McGraw Hill, 1997

Outline:

1. Completely mixed Systems
   - CSTR, waste loadings, steady state and time variable solutions
2. Incompletely mixed Systems
   - PFR, mixed-flow, diffusion, dispersion
3. Water Quality Environments
   - Rivers, lakes, estuaries

Exam #1 (In Class, 50 minutes)

4. Dissolved Oxygen and Pathogens
   - Streeter-Phelps, BOD, DO, Nitrogen
5. Eutrophication and Temperature
   - Algal growth, heat budgets, light effects
6. Computer Mechanistic Models
   - QUAL2E, EXAMS
7. Stochastic Models
   - Export coefficients, phosphorous loading functions
8. Chemical Modeling
   - Heavy metals, toxic organics, pharmaceutically-active compound

Exam #2 (In Class, 50 minutes)

Tentative Schedule of Topics

Wk	Dates	Topics	Readings
1	Jan 22	I. Completely Mixed Systems Introduction to Water Quality Estimation	1) Chapra L1
	Jan 24	Reaction Kinetics	2) Chapra L2
2	Jan 27	Mass Balance, Steady-State Soln, and Response Time	3) Chapra L3
	Jan 29	Particular Solutions	4) Chapra L4
	Jan 31	Computer Methods: Well-Mixed Reactors	5) Chapra L7
		HW1: [ ]	
3	Feb 3	II. Incompletely Mixed Systems Diffusion	6) Chapra L8
	Feb 5	Distributed Systems (Steady-State)	7) Chapra L9
	Feb 7	Distributed Systems (Time-Variable)	8) Chapra L10
		HW2: [ ]	
4	Feb 10	III. Water-Quality Environments Rivers & Streams	9) Chapra L14
	Feb 12	Lake & Impoundments	10) Chapra L16
	Feb 14	Sediments	11) Chapra L17
5	Feb17 (Mon)	HOLIDAY- PRESIDENT'S DAY	
	Feb 19	The "Modeling" Environment	12) Chapra 18
		HW3: [ ]	
	Feb 21 (Fri)	EXAM 1	
6	Feb 24	IV. Dissolve Oxygen and Pathogens BOD and Oxygen Saturation	13) Chapra L19
	Feb 26	Gas Transfer Oxygen Reaeration	14) Chapra L20
	Feb 28	Streeter-Phelps: Point Sources	15) Chapra L21
7	Mar 2	Streeter-Phelps: Distributed Sources	16) Chapra L22
	Mar 4	Nitrogen	17) Chapra L23
	Mar 6	Photosynthesis/Respiration	18) Chapra L24
8	Mar 9	Sediment Oxygen Demand	19) Chapra L25
	Mar 11	Computer Methods QUAL2K	20) Chapra L26
		HW4: [ ]	
	Mar 13	NO CLASS	
9	Mar 16 (Mo-F)	SPRING RECESS	

10	Mar 23	NO CLASS	
	Mar 25	V. Eutrophication and Temperature The Eutrophication Problem and Nutrients	21) Chapra L28
	Mar 27	Phosphorus Loading Concept	22) Chapra L29
11	Mar 30	Heat Budgets	23) Chapra L30
	Apr 1	Plant Growth and Nonpredatory Losses	24) Chapra L33
	Apr 3	Eutrophication in Flowing Waters	25) Chapra L36
		HW5: [ ]	
12	Apr 6	VI. Toxics Introduction to Toxic-Substance Modeling	26) Chapra L40
	Apr 8	Mass-Transfer Mechanisms: Sorption and Volatilization	27) Chapra L41
	Apr 10	Reaction Mechanisms: Photolysis, Hydrolysis, and Biodegradation	28) Chapra L42
13	Apr 13	Radionuclides and Metals	29) Chapra L43
	Apr 15	Toxicant Modeling in Flowing Waters	30) Chapra L44
		HW6: [ ]	
	Apr 17	EXAM 2	
14	Apr 20 (Mon)	Holiday- Patriot's Day	
	Apr 22	VII. Special Topics:	31) Handouts
	Apr 24	VII. Special Topics:	32) Handouts
15	Apr 27	VII. Special Topics:	33) Handouts
	Apr 29	VII. Special Topics:	34) Handouts

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